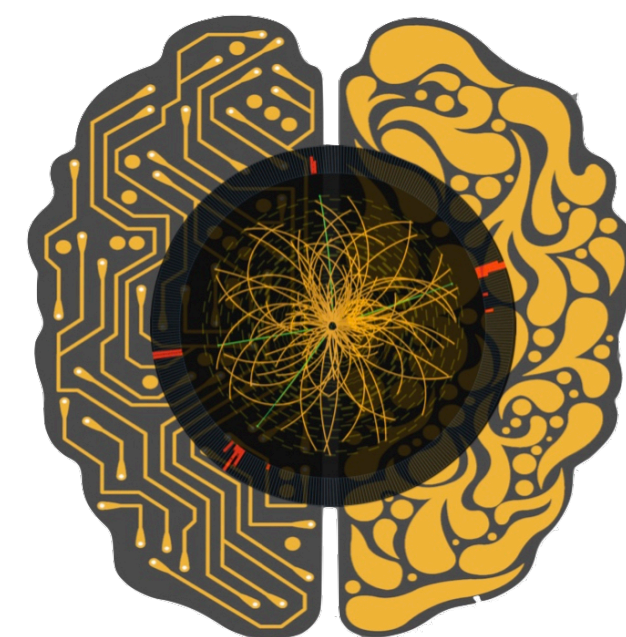
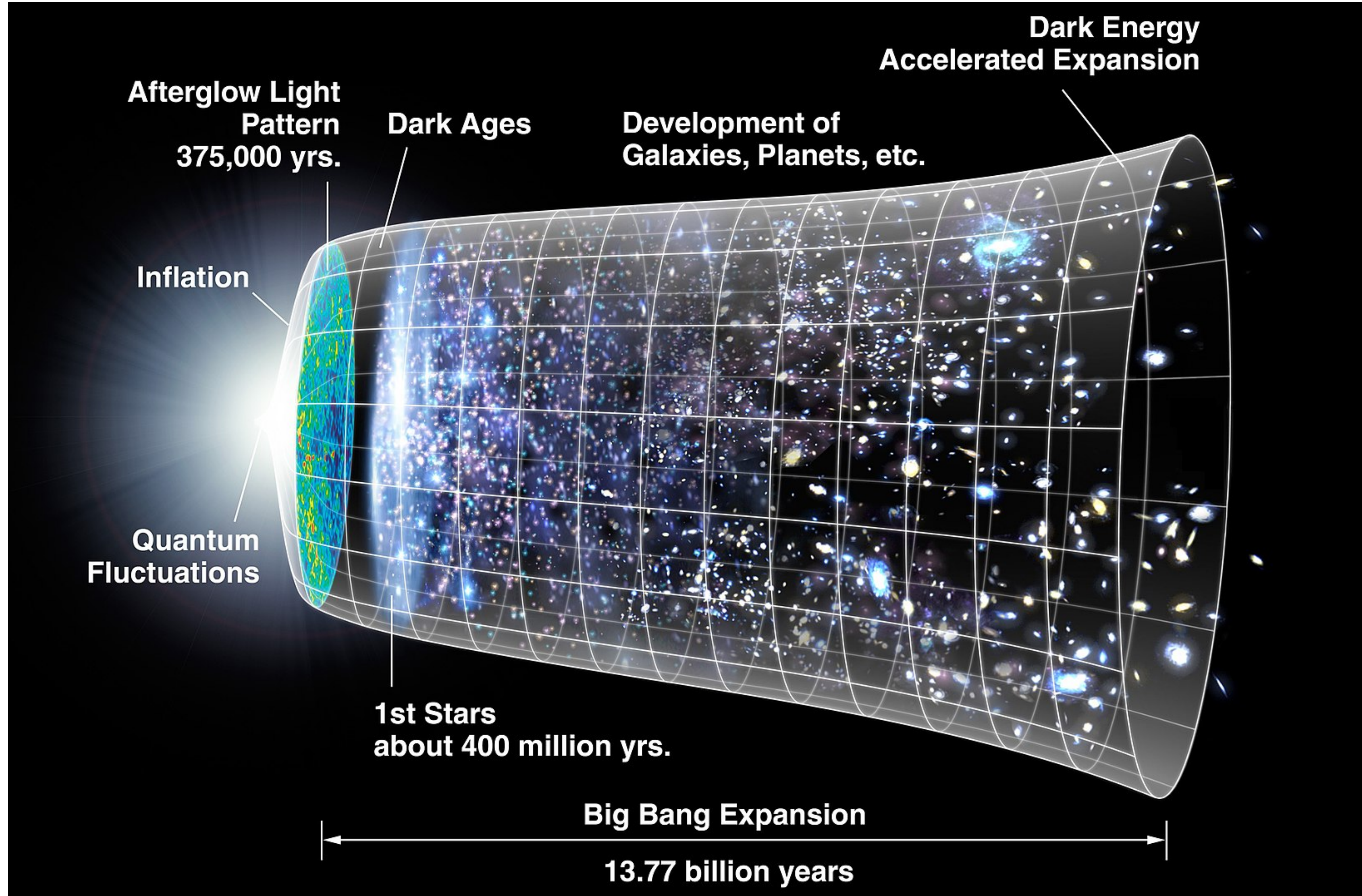


# A3D3 HEP activities

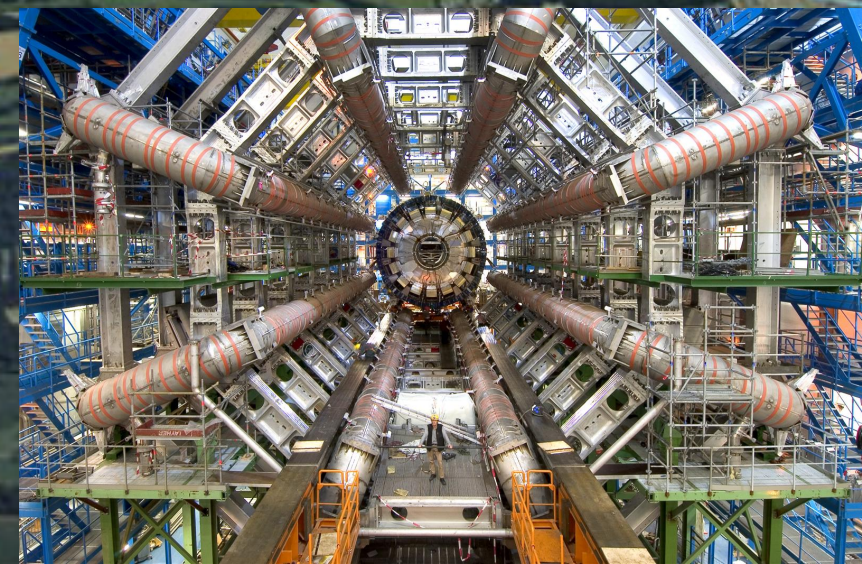
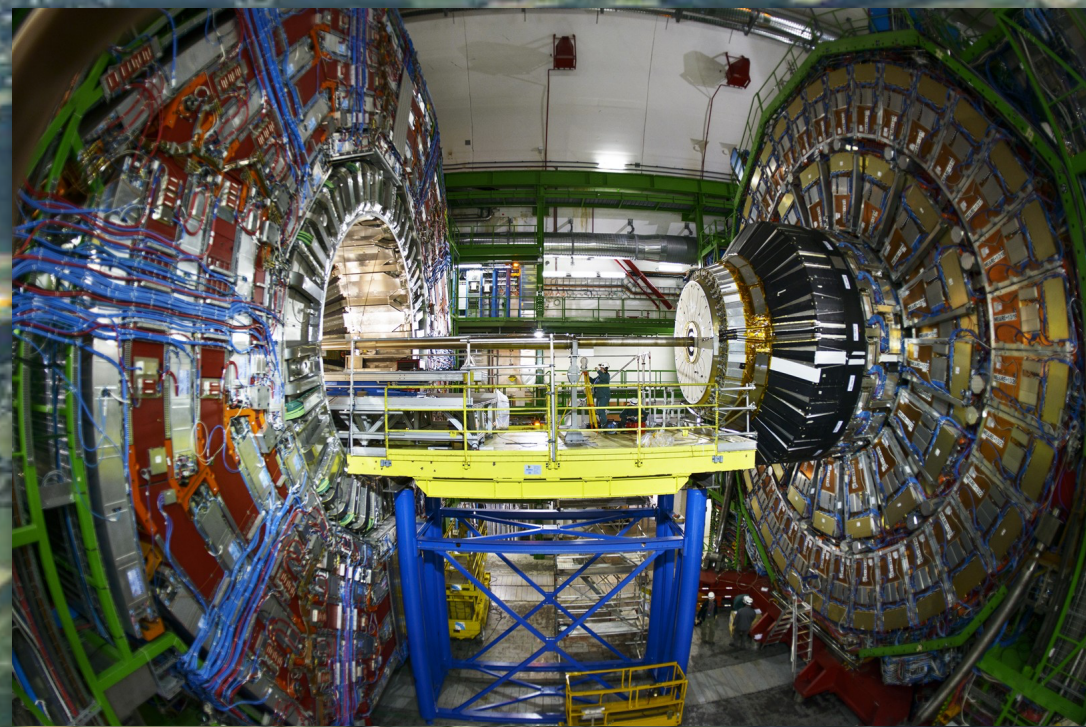
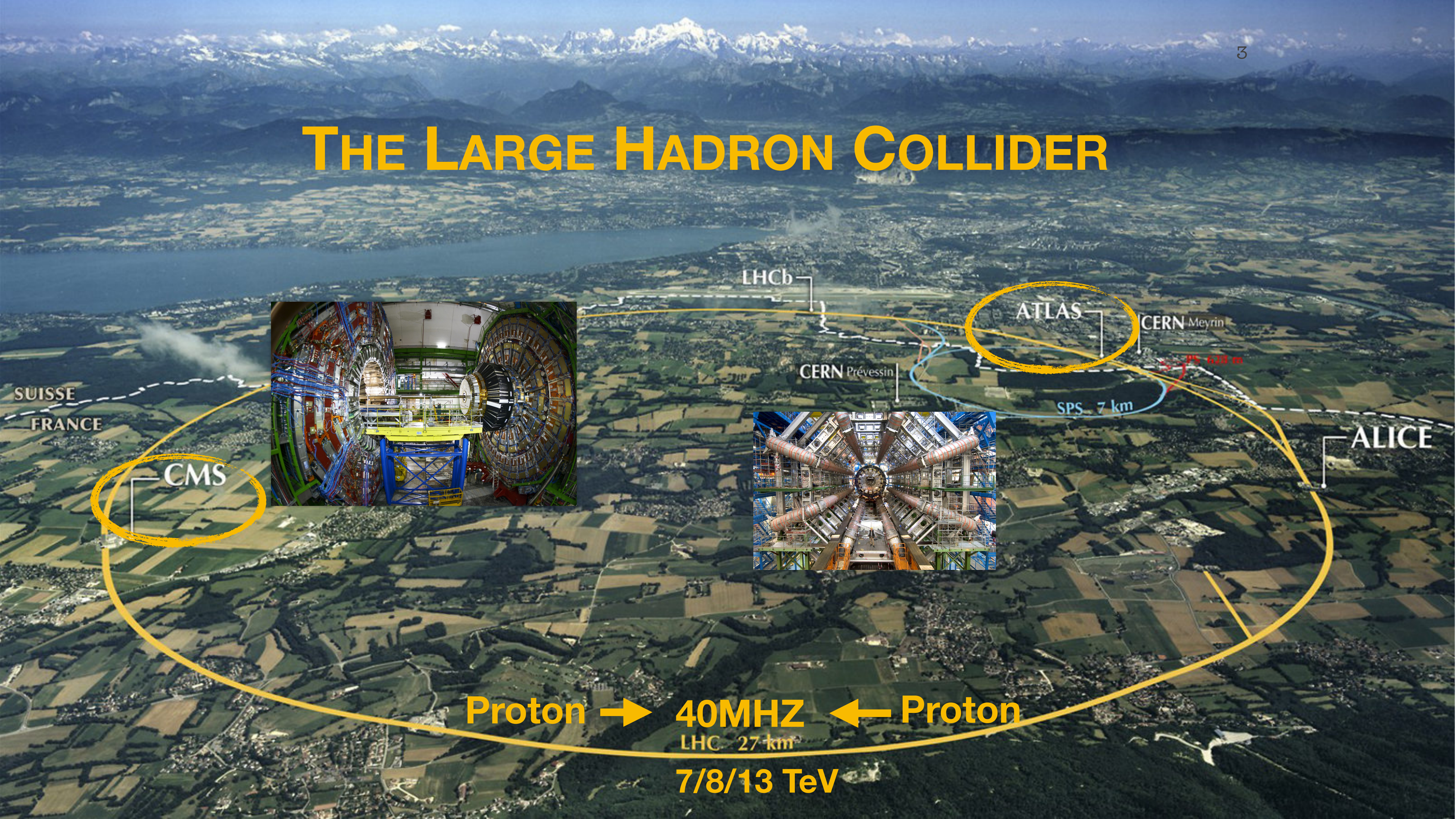
Mia Liu  
Purdue University



# Recreating the universe after the big bang<sub>2</sub>



# THE LARGE HADRON COLLIDER



CMS

ATLAS

LHCb

CERN Prévessin

CERN Meyrin

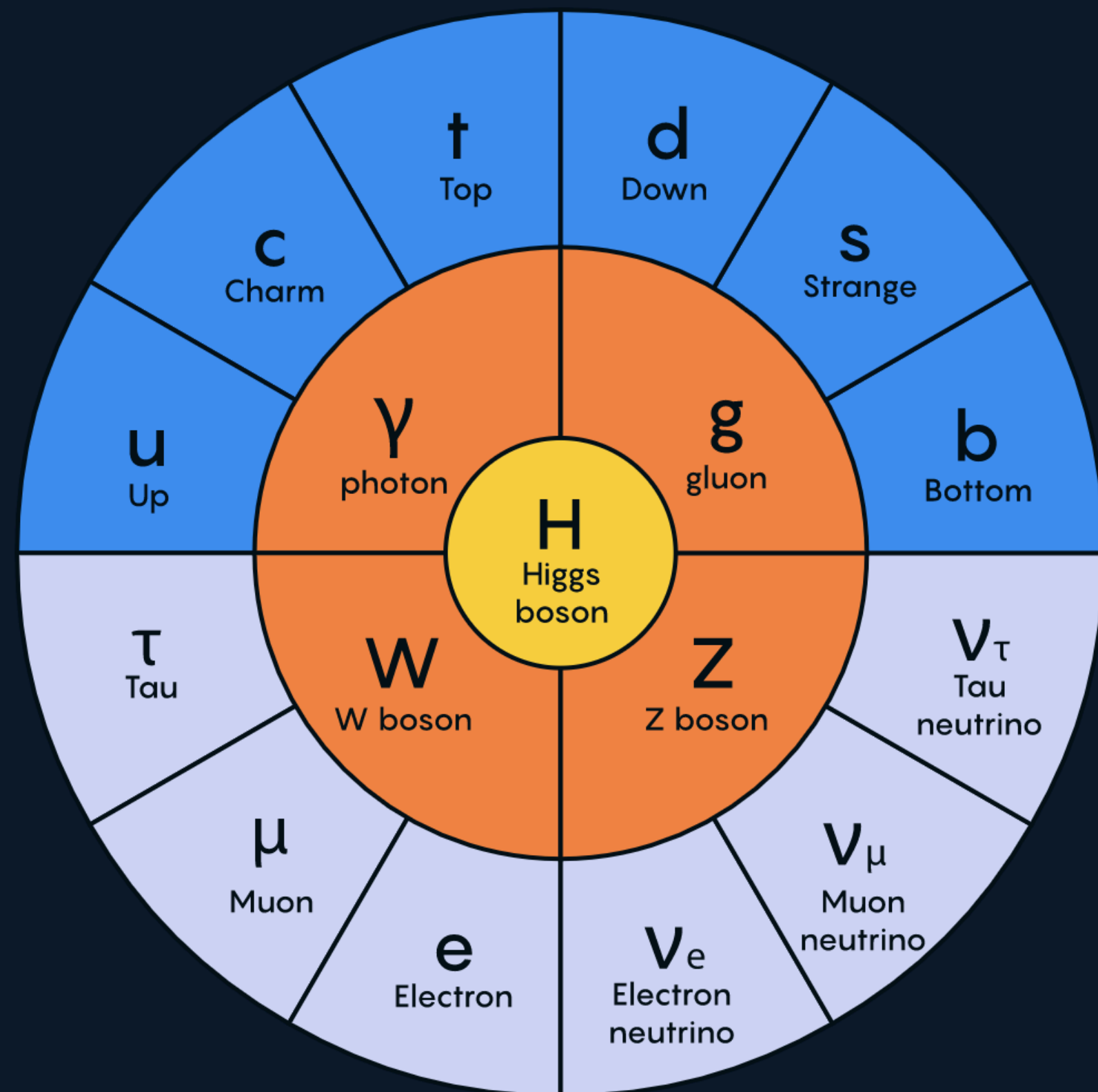
SPS 7 km

ALICE

SUISSE  
FRANCE

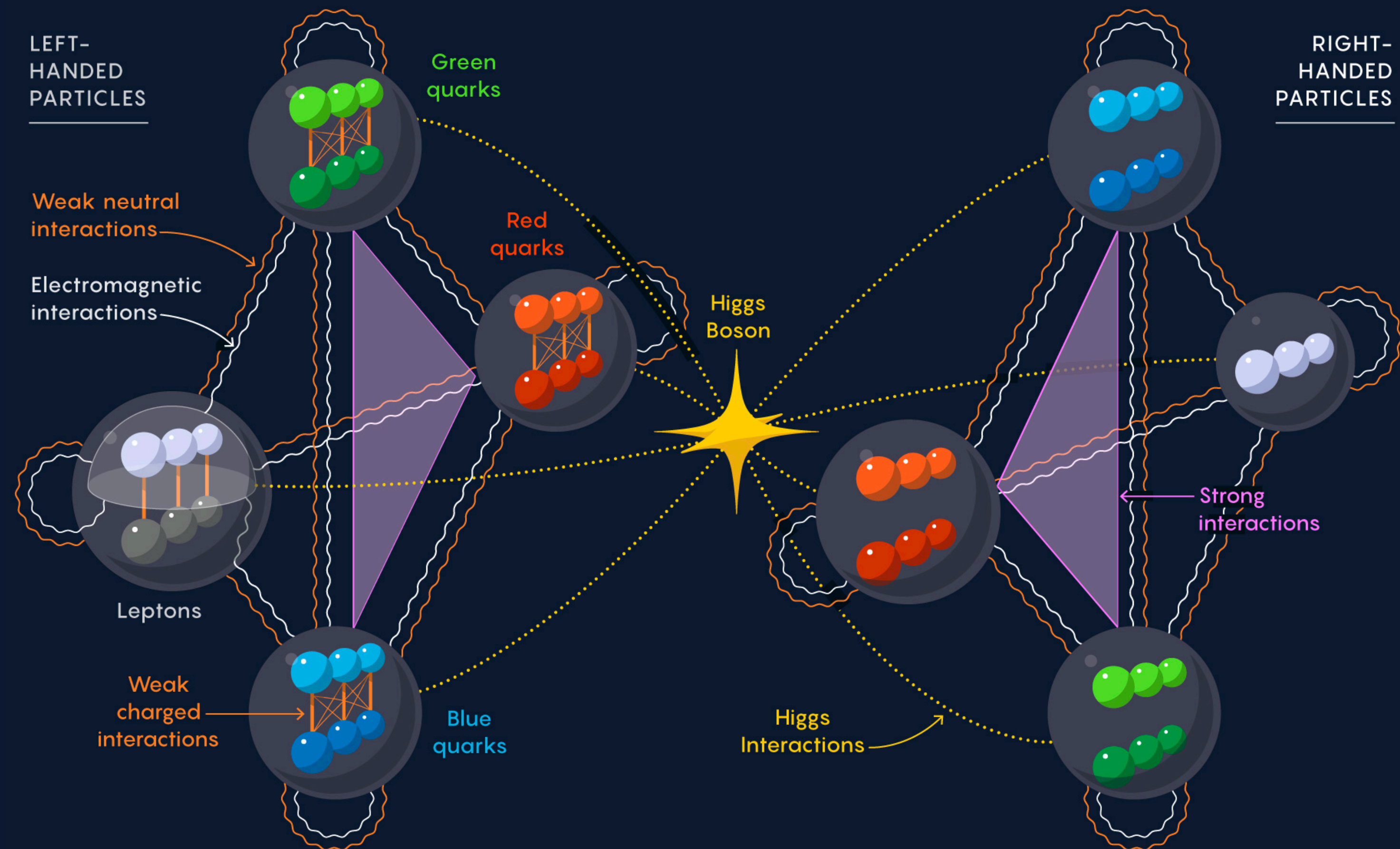
Proton → 40MHZ ← Proton  
LHC 27 km  
7/8/13 TeV

# The Standard Model of Fundamental Particles <sup>4</sup>



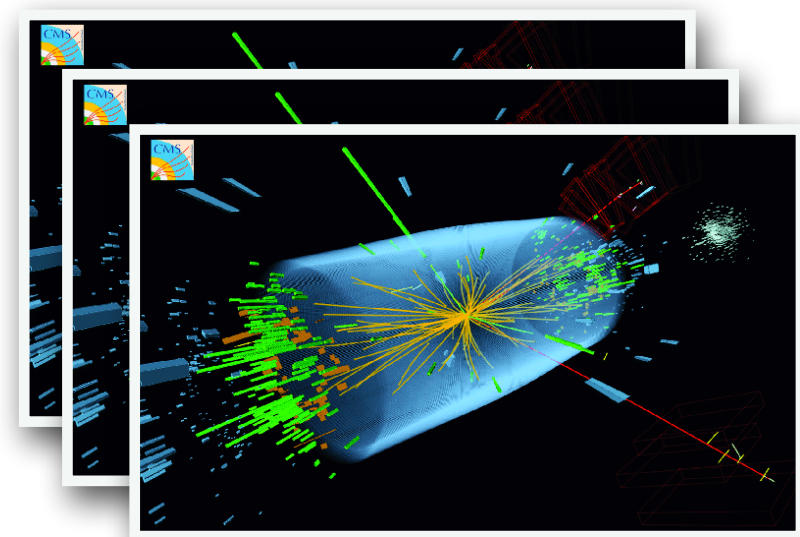
FERMIONS (MATTER)      BOSONS (FORCE CARRIERS)

● QUARKS   ● LEPTONS   ● GAUGE BOSONS   ● HIGGS BOSON



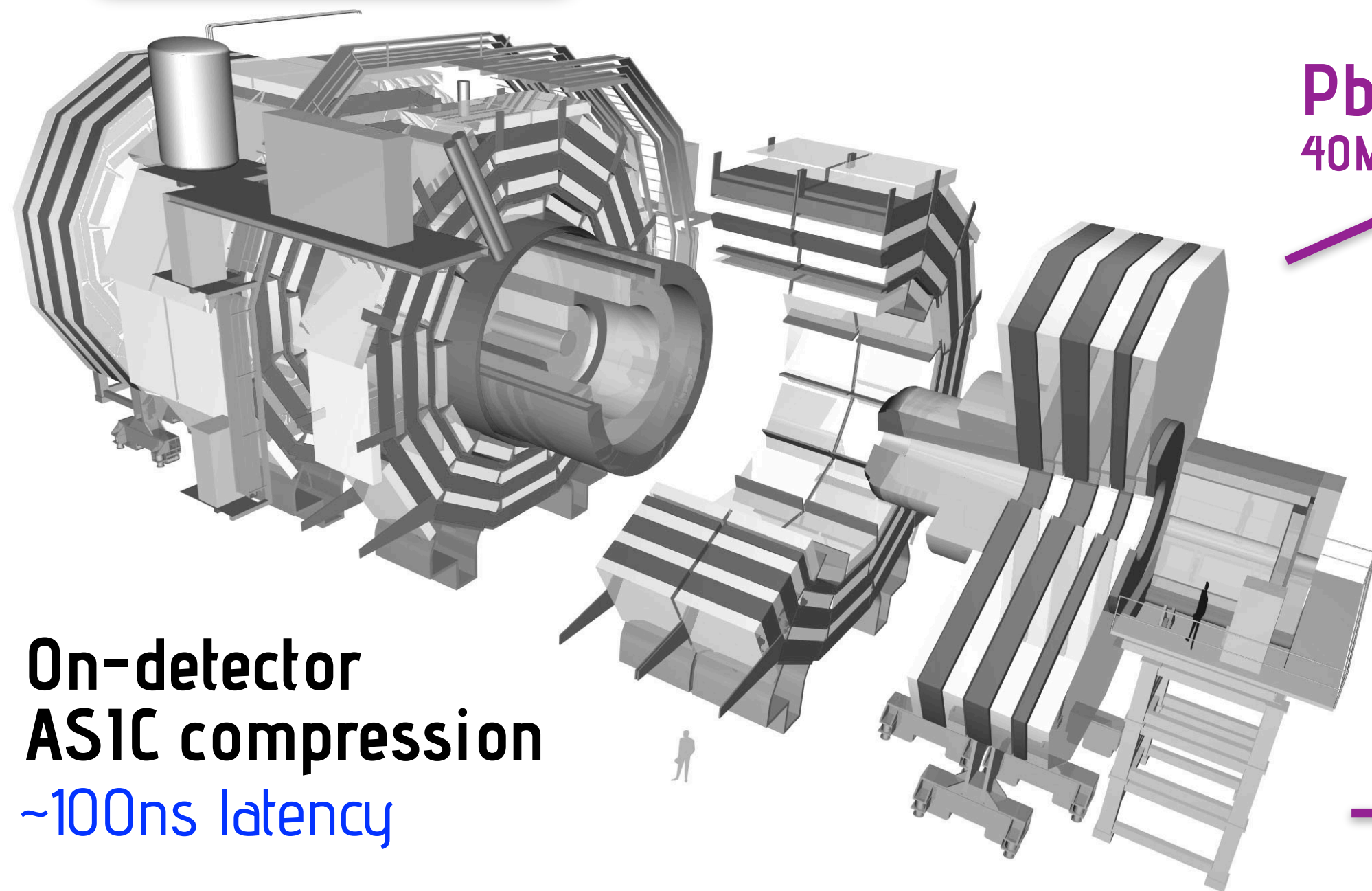
- SM is incomplete: no dark matter candidate/ unstable Higgs mass
- Well motivated BSM theory space excluded with LHC searches
- Need to be inclusive in signatures to detect at the LHC for upcoming runs
  - Higher data rate, more complex detector design

# From Collisions to Discoveries



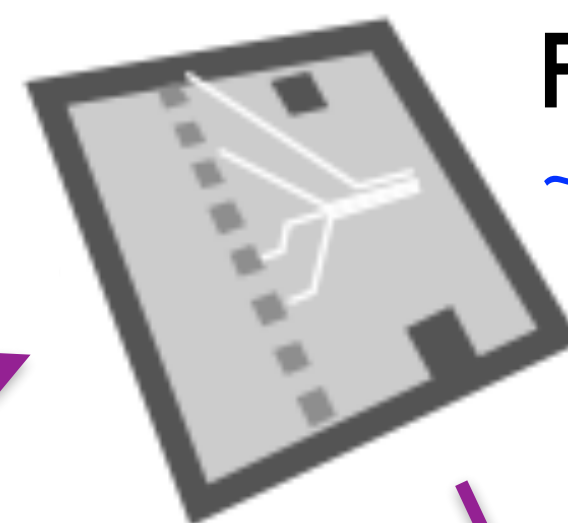
## CMS Experiment

40MHz collision rate  
~1B detector channels



On-detector ASIC compression  
~100ns latency

Pb/s  
40MHz

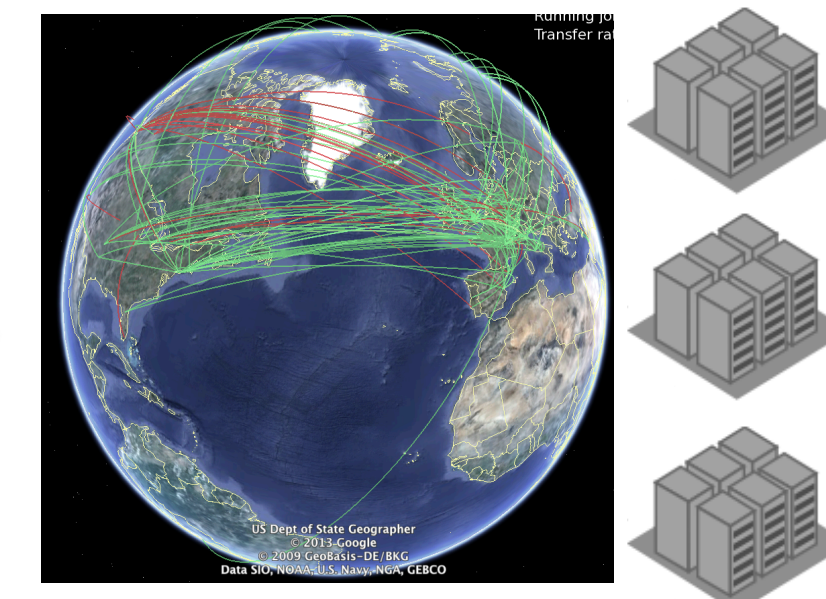
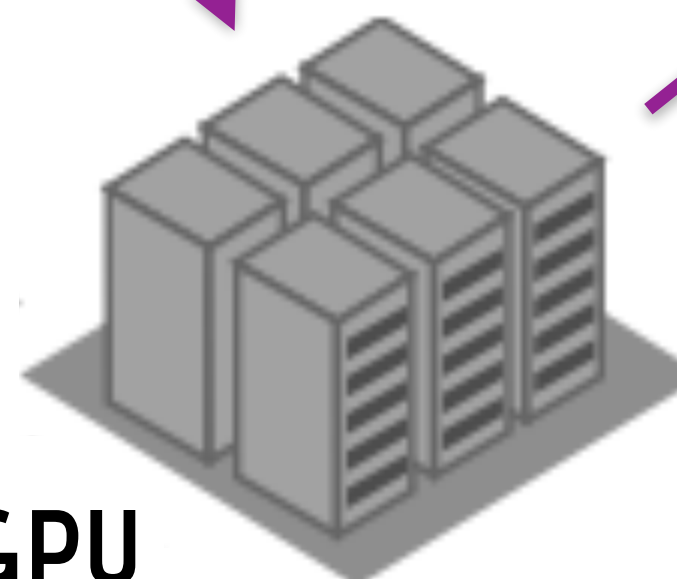


FPGA filter stack  
~μs latency

10s Tb/s  
100s kHz

On-prem CPU/GPU filter farm  
~100 ms latency

10s Gb/s  
~5 kHz



Worldwide computing grid  
Exabyte-scale datasets

# Accelerated AI in HEP

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Pre-kickoff seminar: <https://indico.cern.ch/event/1087356/>

## Opportunities in accelerating discoveries at the LHC with AI:

- Searching for more challenging unconventional signatures: e.g. boosted/low momentum/long lived
- Efficient easily parallelizable methods to speed up computing.
- Future: online calibration, intelligent experimental control etc

**Bringing algorithms closer to data creation with AI in Level 1 trigger/on-detector ASICs** : targeted systems

**Large data volume requires efficient data-processing at the high level trigger and offline computing:** heterogeneous computing

**Full ML device implementations require algorithm & hardware co-design and tools that assist domain experts with prototyping**

## HEP parallel session later today

er: Miaoyuan Liu (Purdue University (US))

### Graph neural networks in HEP

10 mins talk + 5 mins discussion

**Speaker:** Yongbin Feng (Fermi National Accelerator Lab. (US))

### Anomaly detection in HEP

10 mins talk + 5 mins discussion

**Speaker:** Sang Eon Park (Massachusetts Inst. of Technology (US))

### SPVCNN applications in HEP

10 mins talk + 5 mins discussion

**Speaker:** Alexander Joseph Schuy (University of Washington (US))

# Look forward to the next few years!

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